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# REPORT ON THE ENUMERATION OF THE 1986 UPSTREAM MIGRATION OF ARCTIC CHARR IN THE HORNADAY RIVER, N.W.T. AND THE EVALUATION OF A WEIR AS A METHOD OF CAPTURING FISH FOR COMMERCIAL HARVEST

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## 1.0 INTRODUCTION

The residents of Paulatuk, N.W.T. have traditionally harvested the local resources of Arctic charr for domestic consumption. The majority of these fish have been taken from the Hornaday River which is located 14 km east of Paulatuk. Two other systems in the vicinity, the Brock River and an unnamed lake, have anadromous Arctic charr populations but fishing pressure in these locations has been relatively insignificant (P. Green, Paulatuk HTA, Inuvik, personal communication). In 1972 a sport fishing lodge was established on the Hornaday River by the Paulatuk Hunters and Trappers Association (HTA). The lodge, located 9 km upstream from the mouth of the river, operated for two years and was then closed due to lack of interest. Residents report that the number of fish taken during this period was minimal and that current angling pressure remains limited.

In 1968 a commercial fishery was established on the Hornaday River by the local residents and a quota of 6,800 kg round weight (rnd. wt.) was set by the Department of Fisheries and Oceans (DFO). The quota has remained unchanged to date and since 1977 the fishery has produced an average of 5,125 kg annually (Table 1). In the past six years the total quota has been reached only once.

Commercial fishing has traditionally been conducted at the mouth of the Hornaday River during the month of August. Approximately eight to ten fishermen are involved, with each individual utilizing one or two monofilament gillnets (139 mm stretched mesh) of 50 to 100 metres in length. The fish captured are dressed on site and returned to Paulatuk by boat where they are placed in a blast freezer. The majority of these fish are sold in Inuvik, with a few being sold locally through private sales.

In recent years, the Paulatuk HTA has been approached by the market in Inuvik to provide a fish of higher quality, i.e. fresher condition and without gillnet marks on the skin. Interest was also shown for an increased harvest as approximately 1000 kg of Arctic charr had to be imported into Inuvik from the eastern arctic in 1985 (Paul Mark, Ulu Foods, Inuvik, personal communication). This, coupled with the fact that the HTA had expressed concern in recent years over reduced catches from the Hornaday River, prompted the initiation of the present study. This study, developed by the Paulatuk HTA, the DFO, and the Economic Development and Tourism Branch of the Government of the Northwest Territories (GNWT), proposed to construct a conduit weir on the Hornaday River to monitor the upstream migration of Arctic charr during the fall of 1986. The primary objectives of the study were to 1) conduct a total stock assessment of the upstream migrating charr population in order to determine whether or not quotas should be raised or lowered and 2) to conduct a feasibility study on the use of a fish weir for commercial fishing on the Hornaday River.

This project has been funded by the DFO (Government of Canada) and the Economic Development and Tourism Branch of the GNWT. The study was conducted under contract by North/South Consultants Inc. with the assistance of the Paulatuk HTA.

## 2.0 STUDY AREA DESCRIPTION

Originating approximately 100 km due north of Dease Arm on Great Bear Lake, N.W.T., the Hornaday River runs northwest for 260 km through the Melville Hills before emptying into Darnley Bay in the Amundsen Gulf region of the Arctic Ocean (Fig. 1). During high tide the mouth of the Hornaday River (69' 21"N 123' 42"W) is approximately 40 minutes by boat to the east of Paulatuk. Travelling time increases greatly at low tide as the southern end of Darnley Bay is extremely shallow and contains numerous sand bars.

The mouth of the Hornaday River consists of a broad delta that stretches approximately 7 km across and 7 km inland. The river bed is predominantly sand and gravel and consists of numerous channels averaging less than one metre in depth. Further upstream, the channels converge and the river cuts through an escarpment which rises to over 200 m in height. Here the river bed is bordered by steep cliffs of over 30 m, beneath which lie broad flood plains. Large cobble, rocks and alternating rapids and deep holes become more predominant further upriver. Approximately 45 km upstream a 20 m waterfall exists which is thought to block all further upstream fish migrations (Sutherland and Golke, 1978).

The Hornaday River is generally between 40 and 100 m wide with depths ranging from less than .5 m to 3 m or more. The water is generally clear except in spring or after rainfall when debris out of the surrounding Melville Hills makes the water extremely turbid. Runoff in the watershed occurs quickly and water levels and river widths tend to fluctuate significantly with respect to the weather. There are no major lakes within the 14670 sq. km watershed. However, there are a number of shallow headwater lakes that drain into the system via small creeks.

# 3.0 METHODS AND MATERIALS

## 3.1 TYPE OF WEIR CONSTRUCTED

Historically, the Inuit of the Canadian Arctic have used stone weirs for domestic fishing. Although this practice is rarely used today, various designs of weirs have been used by biologists to assess migratory fish populations since 1938.

The construction of the weir used in the 1986 Hornaday River test fishery was based on a design of a conduit fence by Anderson and McDonald (1978). This design was modified slightly by placing the conduit closer together (3.2 cm centres) to insure that a total count of upstream migrants was achieved. Further modification included the addition of a holding pen for the commercial fishery. A list of the weir materials is presented in Appendix I.

A conduit weir was selected over other designs primarily because of its superior qualities of strength, longevity and portability. It was necessary to use a weir design that could withstand the water velocity and volume of the Hornaday River as well as be re-assembled in subsequent years for further commercial fishing. The weir material also had to be portable enough to be transported by aircraft and by small aluminum fishing boats. Other design advantages as compared to a wire mesh weir include: decreased mortality and damage to fish, ease of construction in high water velocities, ability to follow bottom contours, a reduced tendency to clog up with debris, and the incorporation of a sorting mechanism to retain only the large commercial sized fish.

Materials for the weir were purchased in Winnipeg and shipped to Inuvik via truck. Based on reports that the river was 40 m wide, 85 m of fencing material was acquired. Lumber for the weir was purchased in Inuvik.

## 3.2 SITE SELECTION

On August 5 a survey of the river was conducted in order to select an appropriate site to construct the weir. A suitable location was found approximately 3/4 km above the convergence of the delta channels at 69° 18'N 123° 46'W (Fig. 1). The river at this point was 1.2 m deep and 85 m wide. The current was slow enough to allow for construction of the fence and the substrate consisted of large cobble which would eliminate undercutting problems. Most importantly, because of inaccessibility to the site by boat due to low water levels in the delta, a landing strip suitable for a wheel equipped Twin Otter aircraft was located within 600 m. This facilitated delivery of the fencing material to the site and the transport of commercial fish to the market.

## 3.3 WEIR CONSTRUCTION

On August 6 materials for the weir were flown direct from Inuvik to the weir site. Three Twin Otter loads of 1460 kg each were dropped off at the airstrip and transferred by All Terrain Cycle (ATC) and wooden sled to the riverside. Construction of the weir and trap took six men three days to complete. This included cutting conduit and lumber, assembling tripods, building the trap and assembling the weir in the river.

The trap (Fig. 2) was constructed of spruce "2 x 4's", 1.27 cm spruce plywood and 2.54 cm stucco wire. It was placed in 0.6 m of water, 25 m from shore and was held down by rocks piled on "2 x 4" cross members nailed to the bottom. The conduit fence (Fig. 3) was assembled following the method used by Anderson and McDonald (1978) and was attached to the trap by 2.54 cm stucco wire and stove pipe wire.

Based on a river width estimate of 40m, insufficient conduit had been purchased (85m) to construct a weir of 135m across the entire 85m width of river at the selected location. Therefore, approximately 50m of the weir and holding pen had to be completed using stucco wire and t-bars. The original plan was to remove every second conduit from the upstream side of the holding pen to act as a sorting mechanism and effectively concentrate only the larger sized fish for commercial harvest. However, the use of stucco wire did not allow for this and therefore fish had to be selected by dipnet from the trap and then placed in the holding pen. Although the weir became fully operational for enumerative purposes on August 9, the holding pen was not installed until August 18. The layout and dimensions of the weir are illustrated in Fig. 4.

## 3.4 BIOLOGICAL EVALUATION

All fish that passed through the trap were enumerated. Fish were either counted as they passed through a sliding door on the upstream side of the trap or dipnetted in the trap and counted as they were released. Approximately 50 Arctic charr were live sampled each day for length (±1 mm) and weight (±25 g). Due to inclement weather and lack of manpower this was not always possible. Each length interval in the daily length frequencies was weighted according to the strength of the run on that particular day and the cumulative totals were used to calculate a total length frequency. The average length and weight for the entire run was also calculated in a similar way. In order to establish a length-age relationship, ten fish from each 5 cm length interval were dead sampled and sagittal otoliths extracted. The otoliths were "aged" by DFO's Fish and Marine Mammal Management Division. A sample of 50 Arctic charr and 50 broad whitefish were individually bagged and sent whole to the freezer in Paulatuk. From there they were sent to Inuvik to be picked up by DFO staff for further analysis.

Analysis of biological data was performed using the Statistical Analysis System (1979). A weight-length relationship was calculated by using a least square regression analysis on logarithmic transformations of fork length and round weight. The relationship is represented as:

$$\text{Log}_{10}\ W = a + b\ (\text{Log}_{10}\ L)$$

The relative condition factor K was calculated by:

$$K = \frac{W \times 10^5}{L^3}$$

L = Fork Length (mm)
W = Round Weight (g)

Mean condition factors were calculated for each day and age.

A mortality rate was calculated by applying the age-length relationship generated from the stratified dead sample to the cumulative daily length frequency. The percentage of each age in each 50 mm length interval of the stratified dead sample was determined and then applied to the cumulative daily length data. An age frequency was then calculated and a catch curve fitted to the data. Instantaneous total mortality (Z) was calculated using a least squares regression on the descending limb of the catch curve. Only age groups that were fully recruited into the migration were used in the calculation.

## 3.5 COMMERCIAL FISHERY

On August 4 a meeting was held between the Project Biologist and the Paulatuk HTA. It was decided that the weir test fishery would remove 1400 kg, dressed weight (dr. wt.), of commercial fish in order to pay the salary of the two local fishermen who would work on the project. The remaining 4500 kg (dr. wt.) of the quota was to be taken by gillnet fishermen at the mouth of the river. Arrangements with Ulu Foods to purchase the entire quota had previously been made.

Commencing August 18, fish passing through the trap were selected by "eye" for size and released into the adjacent holding pen. When a sufficient quantity of charr had been collected, a plane was requested (by two-way radio) from Inuvik. Fish were removed from the holding pen using an 18 m x 1.3 m, 2.54 cm mesh seine. Approximately 150 fish were removed with each haul, dispatched with a blow to the head, gutted, and washed. The fish were placed in polyethylene bags and transported to the plane using an ATC and sled. Approximately 15% of all commercial fish from the weir were sampled for length and weight. A tabulation of all sexually mature fish that were taken from the weir during the commercial harvest was also kept along with a limited record of gillnetting conducted by the other commercial fishermen.

The average size of gillnetted fish was calculated by dividing the total weight of one fisherman's catch by the number of fish that he had caught. Catch per unit effort (CPE) and the total number and weight of the domestic catch were roughly estimated through general observation of the fishery. Total dressed weights of the commercial fishery were obtained from Ulu Foods in Inuvik. A conversion factor of .83, which was calculated during the commercial fishery, was used to convert dressed weights to round weights.

Upon completion of the project the fence was disassembled and stored on the riverbank next to the site.

# 4.0 RESULTS AND DISCUSSION

## 4.1 WEIR PERFORMANCE

Installation of the weir was completed on August 9. It was able to withstand rising water levels for an initial four day period and required virtually no maintenance for the duration of the test fishery. The only design problem to occur was the tendency for Arctic charr of approximately 200 mm in length to gill themselves in the 2.54 cm wire mesh that was used to complete the fence and attach the trap. Assuring adequate fencing material and using a smaller diameter plastic or wire mesh would alleviate this problem in future projects. All larger fish were able to move through the system unharmed and did not seem to be inhibited from migrating upstream.

On August 22, a storm with high winds and low temperatures occurred leaving a substantial accumulation of snow in the surrounding Melville Hills. Clear skies and rising temperatures on August 25 resulted in melting snow which led to rising water levels and increased turbidity. Over a span of three days the river level increased by 0.4 m and visibility in the water dropped to less than 10 cm. At approximately 6:00 A.M. on August 28, the weir collapsed due to the additional pressure of the rising water. The weir site was then abandoned for five days during which time the water receded and the visibility improved. On September 3, the weir materials were salvaged from the river and stored on shore for future use. Damage to the fence was minimal with less than 2 m of fence length needing to be replaced.

Future washouts of the weir can be avoided with the experience gained through this year's test fishery. It was found that after heavy precipitation, it took approximately 3 days for the river to crest at its highest level and an additional 3 to 4 days passed before the river levels dropped back to normal. By foreseeing the rising water levels, conduit could be temporarily removed from the weir to alleviate the additional pressure and then replaced once water levels had receded.

## 4.2 BIOLOGICAL EVALUATION

### 4.2.1 Strength and Timing of Run

Daily counts of fish moving upstream began on August 9. Few Arctic charr passed through the weir at this time suggesting that the run had not yet started. On August 15 there was a substantial jump in the daily count with peak numbers (1,570 Arctic charr) passing upstream on August 16. Daily counts remained relatively high for the next week until the storm of August 22. At this time temperatures and daily counts both declined for a period of three days. With the restoration of clear weather on August 25, numbers once again increased and continued to do so until the fence was washed out on August 28. Daily counts are given in Table 2 and illustrated in Figure 5.

Although the washout of the weir precluded a total count, there were a number of indications that the majority of the run had occurred by this time. During the peak of the run only 5% of the fish passing through the weir were less than 400 mm in length. However, during the last two days the weir was in operation 33% of the charr sampled were less than 400 mm in length (Fig. 6). Johnson (1980) found that in the Nauyuk Lake system most charr above 400 mm in length had completed their upstream migration by August 26. After this date he found that almost all charr moving upstream were less than 400 mm and made up less than 25% of the total migrating population. The presence of increased numbers of smaller fish in the Hornaday River two days prior to the weir collapsing suggests that the run was probably coming to an end and that no more than 30% of the run was yet to come. A further indication was the decreasing catch of gillnet fishermen at the river mouth after August 22 and at the weir location after August 28. Local residents say that the majority of the run usually takes place between August 10 and August 25, and it appears that this was the case again this year.

The total count of Arctic charr passing through the weir from August 9 through August 28, when the weir collapsed, was 10,798. By assuming that the smaller size mode (<400 mm) made up the majority of the fish that were left to come, it was estimated that 70% of the run had been enumerated. Thus, it is reasonably safe to assume that the total upstream migration in the Hornaday River during the fall of 1986 (including an estimated domestic and commercial catch of 621 fish) did not exceed 16,047 Arctic charr. This number is considerably less than commercially fished rivers in the vicinity of Cambridge Bay where up to 183,000 Arctic charr have been counted in some migrations (Kristofferson et al., 1984).

Throughout the test fishery both broad whitefish and long nose suckers were encountered daily. Broad whitefish were taken in significantly higher numbers between August 10 and August 20. Whether this was an indication of a migration or whether these fish are year round residents of the Hornaday River was not determined. Two Arctic grayling and one Arctic cisco were also caught during the test fishery.

### 4.2.2 Size, Age and Maturity

Hornaday River Arctic charr show a number of characteristics which are similar to other western North American populations. These fish are generally young and small, and mature and migrate to sea at a younger age relative to stocks in the eastern arctic (McPhail and Lindsay 1970, Glova and McCart 1974, Johnson 1980, Gillman et al. 1985).

The average Arctic charr passing through the weir in 1986 measured 467 mm in length and weighed 1188 g. The smallest charr was 201 mm and weighed 50 g while the largest was 693 mm and weighed 3,875 g. Very few fish over 600 mm in length (<3%) were present in the migrating population which was dominated by the 400-500 mm length interval. Mean fork length and round weight by day are given in Table 3 and a calculated total length-frequency is presented in Fig. 7.

Arctic charr as young as 3 years of age were found to be migrating upstream. Johnson (1980) suggests that small charr may migrate downstream but might remain in freshwater at the river mouth. Whether this occurs in the Hornaday River is unknown, however, it is apparent that charr in this system become part of the anadromous stock at a relatively early age. Glova and McCart (1974) also found charr as young as 3 migrating to sea in the Firth River, Yukon Territory. Conversely, Johnson (1980) found that charr in the Nauyuk Lake system were 5 to 7 years of age before making their first seaward migration. The average Arctic charr passing through the Hornaday River weir in 1986 was 7 years of age while the oldest charr encountered was 11 years of age.

The youngest sexually mature Arctic charr sampled on the Hornaday River was 8 years of age. Data was limited in this area as mature fish made up less than 1% of the 900 fish that were examined from the commercial fishery and stratified dead sample. Johnson (1980) states that Arctic charr in Nauyuk Lake mature at age 10, but seem to mature at younger ages farther west in the Yukon Territory and Alaska (ages 4-6). Because of the young age of Hornaday River charr, one would expect that they would be similar to the western populations in age at maturity.

The female to male ratio of Hornaday River Arctic charr was calculated as 1.1:1. This statistic is extremely variable between populations, ranging from as low as 0.5:1 at Steensby Inlet, Baffin Island (Kroeker, 1985), to 1.4:1 at Nauyuk Lake (Johnson, 1980).

### 4.2.3 Growth

Mean length of each age is shown in Fig. 8. Johnson (1980) states that the correlation between length and age in Arctic charr populations is loose. This is evident in the wide range of lengths for each age in the Hornaday River stock. A comparison of growth rates with other stocks is shown in Fig. 9. Hornaday River charr display a growth rate which approximates those in the central Arctic, however, their life expectancy is much shorter.

The length weight relationship for Hornaday River Arctic charr is:

$$\mathrm{Log}_{10}W = -4.82 + 2.95\ (\log_{10}L)$$

This is comparable to weight-length relationships of other charr populations across the Canadian Arctic.

Mean condition factors for each age class are given in Table 4. The mean condition factor for Hornaday River Arctic charr during the fall migration was 1.13. This indicates a healthy population with respect to "robustness" of the fish and compares favourably to other commercial charr fisheries of upstream migrations.

### 4.2.4 Mortality

Instantaneous total mortality (Z), was calculated from the catch curve using ages 8 through 11 (Fig. 10). A surprisingly low value of 0.40 was obtained with an r value of .90. This figure should be considered cautiously as the age-frequency it represents is calculated from a length-frequency distribution. Kristofferson et al. (1982) states that rivers with rates of mortality of this level are considered to be lightly to moderately exploited. Rivers such as the Ekalluk which are considered to be heavily exploited, have mortality rates in excess of .70 (Kristofferson et al. 1982). The mortality rate calculated for the Hornaday River is probably somewhat of an under estimation due to the lack of an actual age frequency and the error involved in converting lengths to ages.

## 4.3 COMMERCIAL FISHERY

### 4.3.1 Weir Fishery

The commercial fishery at the weir commenced on August 18, 1986. By August 21, 705 Arctic charr had been collected and placed into the holding pen. Arrangements were made for a plane to arrive on August 22 to pick up the fish and deliver them to Ulu Foods in Inuvik. Three additional workers were hired at this time to assist in the harvesting.

Due to poor weather conditions the plane was delayed until August 25. During this period all 705 charr remained within the holding pen and despite a relatively high water velocity, no casualties occurred. It was estimated that the density of charr in the holding pen at this time was 20 kg/m$^3$ which was well below the DFO recommended maximum of 70 kg/m$^3$. Some of the charr had been held captive for up to 7 days.

On August 25 the camp was notified at 10:30 a.m. that a plane was to arrive at 2:30 p.m. Seining, gutting and cleaning started immediately but by the time the plane had arrived only one half of the fish had been processed. An additional four hours were required to clean the rest of the fish, load them into polyethylene bags and move them up to the landing strip. The plane departed the weir site at 6:30 p.m. and arrived in Inuvik approximately 1 3/4 hours later. At this time the fish had been dead for no more than 10 hours.

The weight of the August 25 harvest was calculated in Inuvik as 1,166 kg (dr. wt). Ulu Foods paid $3.85/kg (dr. wt.) which generated $4,490. of revenue. Additional costs were deducted from this to cover: one half of the unused capacity of the aircraft, one half the downtime of the aircraft at the weir location and wages of the individuals hired to help harvest the charr. This left approximately $1,600 for each of the two fishermen who worked on the project full time. These additional costs could be reduced by better communication with respect to plane arrival and weather reports, and by ensuring that the full capacity of the plane is utilized.

Despite some organizational problems, the weir proved to be an excellent method of harvesting fish for commercial sale. Transportation of fish to Inuvik was extremely efficient with the availability of the landing strip within 600 m of the weir location. The weir itself appeared to do no harm to the non-commercial portion of the migrating population other than a few casualties related to the stucco wire and sampling. The charr collected for commercial harvest were kept in relatively low densities in the holding pen and were in prime condition when the harvest commenced. The total harvest took less than eight hours and the fish sent to Inuvik retained both their firmness and colour. Although the weir fish were considered by Ulu Foods to be of the highest quality, they yielded the same price as fish caught by gillnets (3.75/kg. dr. wt.).

Gillnetting at the mouth of the river decreased after August 22 and it was subsequently decided by the HTA to harvest more fish from the weir. Between August 25 and 27, a further 103 charr were collected and placed in the holding pen. A local gillnet fisherman and his family harvested these fish on August 27 and delivered them by boat to the freezer in Paulatuk. These fish weighed an estimated 186 kg (rnd. wt.) and were primarily sold locally.

In total, 808 Arctic charr were taken with the weir during the test fishery. The average fish weighed 1,984 g and measured 563 mm in length. The range in weight was 1,250 g to 3,875 g, and in length from 493 mm to 693 mm. The mean condition factor was 1.10. A length frequency distribution is given in Fig. 11 and mean condition factors for each length interval are given in Table 5.

Despite excellent transportation to the weir site by aircraft, transportation to and from Paulatuk by boat proved to be difficult as the weir was located approximately 5 km upstream of the nearest convenient landing site. Travelling time from Paulatuk to the weir took 2 to 3 hours as fishermen were required to either walk or navigate their boats upstream through the shallow delta channels, the latter of which was rarely attempted due to the damage incurred by the outboard motors. As it is uncertain at this time whether the infrastructure in Inuvik is equipped to handle the large volumes of fresh fish harvested via the weir system, some consideration should be given to finding an alternative weir location closer to the mouth of the river which would facilitate direct delivery of fish by boat to the freezer in Paulatuk. Foreseeable problems in relocating the weir to the delta would include:

1) finding a suitable location for weir construction
2) finding a suitable camping location close to the weir
3) finding an accessible storage location for the weir above spring high water levels
4) loss of the landing strip for a wheel equipped aircraft

A partial span weir has proven to work successfully in other commercial charr fisheries (A. Kristofferson, DFO, Wpg., personal communication) and should prove to be adequate on the Hornaday River. This would enable the HTA to meet current Fisheries regulations which prohibit blocking more than 2/3 the width of a stream or river during commercial fishing. The existing materials on site at the Hornaday River would be sufficient to build a complete partial span weir and holding pen of conduit, which would allow for the installation of a sorting mechanism on the upstream side of the holding pen.

### 4.3.2 Gillnet Fishery

Gillnet fishermen at the mouth of the Hornaday River took the majority of their catch between August 10 and August 22. Approximately fifteen, 50 m nets were in use, and at the peak of the run produced up to 35 Arctic charr/50 m net/24 hrs. With the decrease in intensity of the run on August 22, nets were placed upstream and downstream of the weir location. These averaged catches of 2 to 7 charr per night until August 28, after which catches became negligible. By September 4, all nets had been removed from the river except for one of 100 m left in at the mouth. This produced no Arctic charr over a two week period.

The average weight per gillnetted fish was 2.89 kg (rnd. wt.). This figure was calculated from a commercial sample and therefore might be somewhat of an overestimation as local fishermen generally keep smaller fish for domestic use and select the larger ones for commercial sale. In total, the gillnet fishery produced 281 charr weighing 811 kg (rnd. wt.) for commercial sale in Inuvik. This generated a revenue of $2,592.45 which was divided between four fishermen. An undetermined portion of the catch was kept in town to be sold locally. A breakdown of one fisherman's catch of 255 fish indicated that 16% was kept for domestic use and 20% was used for dog food due to spoilage. The remaining 64% were sold to Ulu Foods in Inuvik. The estimated domestic harvest (including cullage and local sales) from the Hornaday River in 1986 was 340 fish weighing approximately 975 kg (rnd. wt.).

### 4.3.3 Weir vs Gillnet Fishery

The entire commercial fishery on the Hornaday River in 1986 produced an estimated 2,402 kg (rnd. wt.) of Arctic charr. Of this, approximately 66% came from the weir fishery which proved to be a much more reliable method of capture than gillnetting. However, it was evident that fish taken via the weir were on average 23% smaller than gillnetted fish. This is partially due to the fact that some of the larger fish had already been harvested and were not available by the time the run had reached the weir. Concerns about taking undersized charr from the weir could be alleviated by establishing a minimum size limit (A. Kristofferson, DFO, Wpg., personal communication).

No fish were lost in the weir system due to inclement weather. This is a definite improvement when considering spoilage of fish in gillnets was estimated to be as high as 20%. When applied to the entire quota this could mean an increased revenue of approximately $5,000 if these fish were to be sold in Inuvik as opposed to being discarded. Fish arriving in Inuvik from the weir were considered by Ulu foods to be much more preferable than gillnetted fish. However, gillnetted fish commanded the same price and subsequently weir fish provided no financial advantage to the fishermen. In similar weir operations in other locations in the Canadian Arctic, fresh fish have been known to generate up to 60% more revenue for the fishermen involved (A. Kristofferson, DFO, Wpg., personal communication).

The weir would prove to be far less labour intensive than gillnetting with the installation of a sorting mechanism in the holding pen. By having the weir lead fish directly into the holding pen, all maintenance except for installation, harvesting and disassembly would essentially be eliminated. A similar type of sorting mechanism has been used elsewhere in the Canadian Arctic and has proved to be extremely efficient (A. Kristofferson, DFO, Wpg., personal communication).

Based on a partial span weir in a suitable location, cost comparisons with conventional gillnet fisheries have shown that over a ten year period operating and capital costs for a weir fishery can be approximately 15% less (A. Kristofferson, DFO, Wpg, personal communication). However, the most significant financial advantages occur with the efficient use of transportation and the reduction in spoilage of fish. Harvesting known quantities of fish at a predetermined time ensures efficient use of boat and aircraft capacity as well as prompt delivery of the fish to freezer facilities.

Based on the results of the test fishery, it was concluded that in suitable locations a weir would be the preferable method of harvesting migrating Arctic charr populations.

Before establishing a weir fishery on any given river there must be:

1) An adequate charr population to sustain a commercial fishery
2) A suitable location to construct a weir
3) Co-operation in the participating community to decide who works on the project and who receives the revenue
4) Adequate means of transportation to a freezer facility
5) A market for the fish
6) A quota large enough to warrant the capital expenditure of a weir purchase

### 4.3.4 Condition and Future of the Hornaday River Commercial Fishery

The results of the 1986 commercial fishery and biological evaluation indicate that the future of this stock is in danger. Gillnet fishermen reported that the CPE this year was the lowest in recent memory which coincides with the fact that the total commercial harvest (the majority of which would not have been taken without the use of the weir) was also the lowest on record (Figure 12). Low numbers, a reduction in the CPE, small size and lack of older fish in the population suggest that this stock has been over-exploited in the past. A comparison of mean lengths and weights of these fish to those from other test fisheries (Table 6) supports this statement.

The Ekalluk River with a population of 183,000 charr is considered to be heavily exploited at its present quota of 14,500 kg (A. Kristofferson, DFO, Wpg., personal communication). In comparison, the Hornaday River supports a quota of just less than half that of the Ekalluk River (6,800 kg) yet has less than one tenth the fish in its resident population. Johnson (1980) suggests that a harvest of 11% of the total fall biomass at Nauyuk Lake appears to be excessive. The estimated total biomass of the upstream migration at the Hornaday River is approximately 20,112 kg (based on 16,047 fish) and therefore provides a very limited base for a yearly commercial harvest of 6,800 kg and a domestic harvest of approximately 925 kg. Even the low harvest of this year estimated at 3,377 kg or 17% of the total biomass, is excessive for a population of this size.

In order to protect this stock there must be a reduction in the current level of harvest from the Hornaday River and sufficient time given to allow the fishery to recover. A decrease in the current quota would be ineffectual as it has not been taken since 1982. As gillnet fishermen generally showed a net financial loss for their efforts in 1986, a further reduction in the current level of harvest would make the fishery even more uneconomical. Thus, it is recommended that the commercial fishery be closed completely and that only the domestic harvest which is vital to the local community be maintained at its present level. This option would have minimal affect on the residents of Paulatuk and be most beneficial to the fishery over the long term. Upon recovery of the charr population, a commercial fishery could be re-established with an appropriate quota allocated in order to assure a sustainable annual harvest.

Further study into the population characteristics of Hornaday River Arctic charr should be undertaken to determine the degree of fluctuation in numbers, spawning characteristics and the ability for the population to recover from its decline. It is also recommended that alternative sites in the vicinity of Paulatuk be investigated for their potential to support either a commercial or domestic fishery in order to alleviate the current fishing pressure on the Hornaday River.

## 5.0 SUMMARY ASSESSMENT

### 5.1 BIOLOGICAL EVALUATION

1) The 1986 fall migration of Arctic charr in the Hornaday River occurred between August 9 and September 1.
2) The highest total daily count of upstream migrants (1570) occurred on August 16.
3) A total of 10,798 charr were counted moving upstream and the estimated total count, including a gillnet catch of 621 charr, was calculated at no more than 16,047 fish.
4) Hornaday River charr were small and young, but display a comparable growth pattern to eastern and central populations.
5) Low mean age, mean length, CPE, and total count indicate that the Hornaday River Arctic charr population has been heavily exploited.

### 5.2 COMMERCIAL FISHERY

#### 5.2.1 Weir Performance

1) The site selected for the 1986 weir operation is suitable as a commercial fishing site.
2) The Hornaday River is subject to flooding but appropriate measures can be taken to avoid washouts.
3) Transportation to the weir site was adequate by aircraft but improvements should be made for transportation to and from Paulatuk.
4) The weir produced a top quality product which the market preferred over gillnetted fish.
5) The weir proved to be an excellent method of harvesting fish and would be more flexible and economical than gillnetting over the longterm.

#### 5.2.2 Potential for a Commercial Fishery

1) The Arctic charr population is too low at this time to support the present commercial quota.
2) Reducing the current quota would be ineffectual as the quota has not been reached in 4 years.
3) Consideration should be given to closing the commercial fishery until the population has recovered.
4) Further studies should be conducted in order to determine fluctuations in the numbers of upstream migrants, whether emigration is occurring, and the spawning potential of the population.
5) Surveys should be conducted to determine if other systems in the Paulatuk area are suitable for either commercial or domestic fishing in order to provide an alternative to the over-exploited Hornaday River stock.

## 6.0 ACKNOWLEDGEMENTS

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NSC

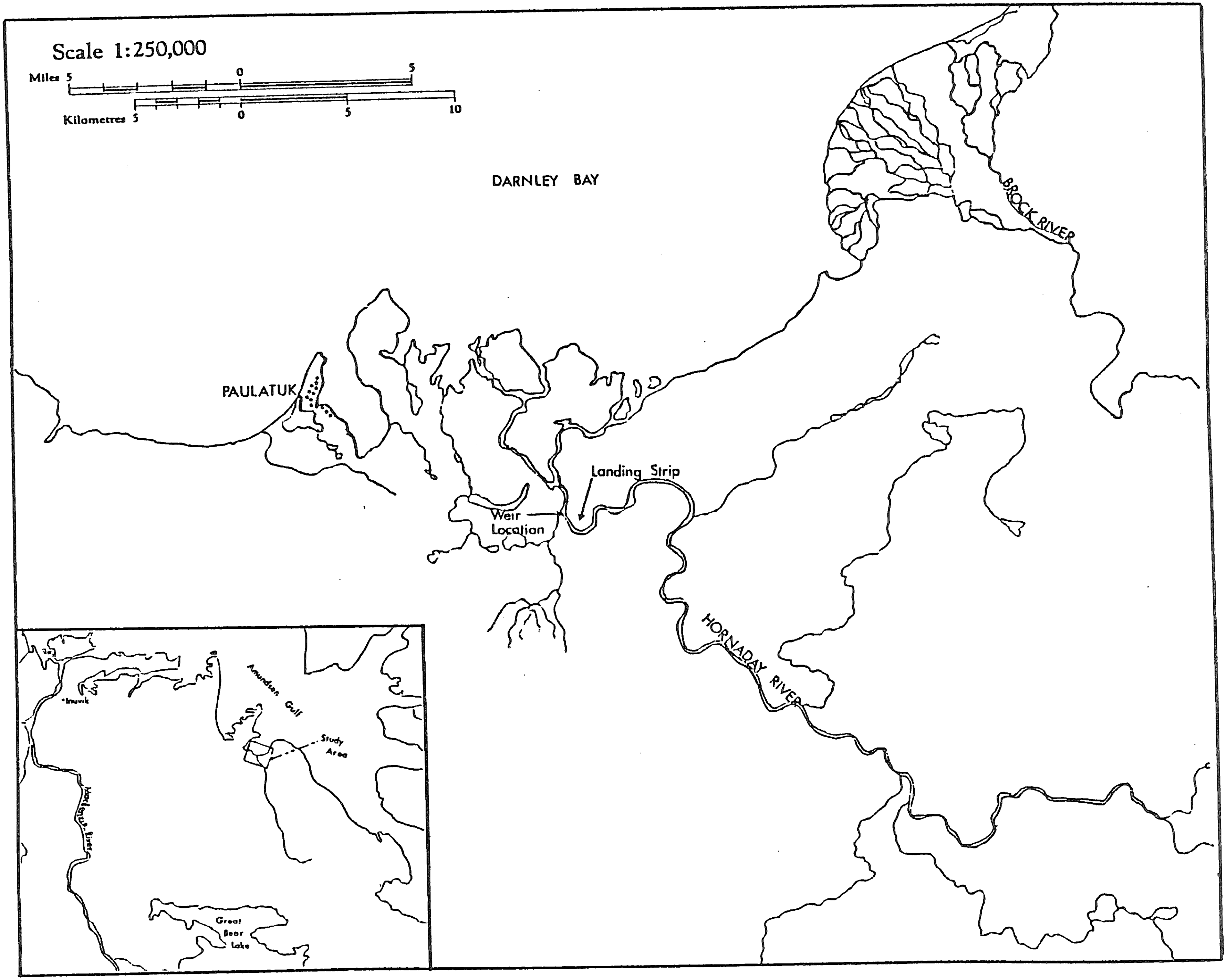



Fig. 1. Map of the Hornaday River test fishery location and surrounding area.

Fig. 2. Upstream view of the trap used for the capture and enumeration of Arctic charr during the 1986 Hornaday River test fishery.

Fig. 3. Downstream view of the conduit fence used to concentrate and enumerate Arctic charr during the 1986 Hornaday River test fishery.

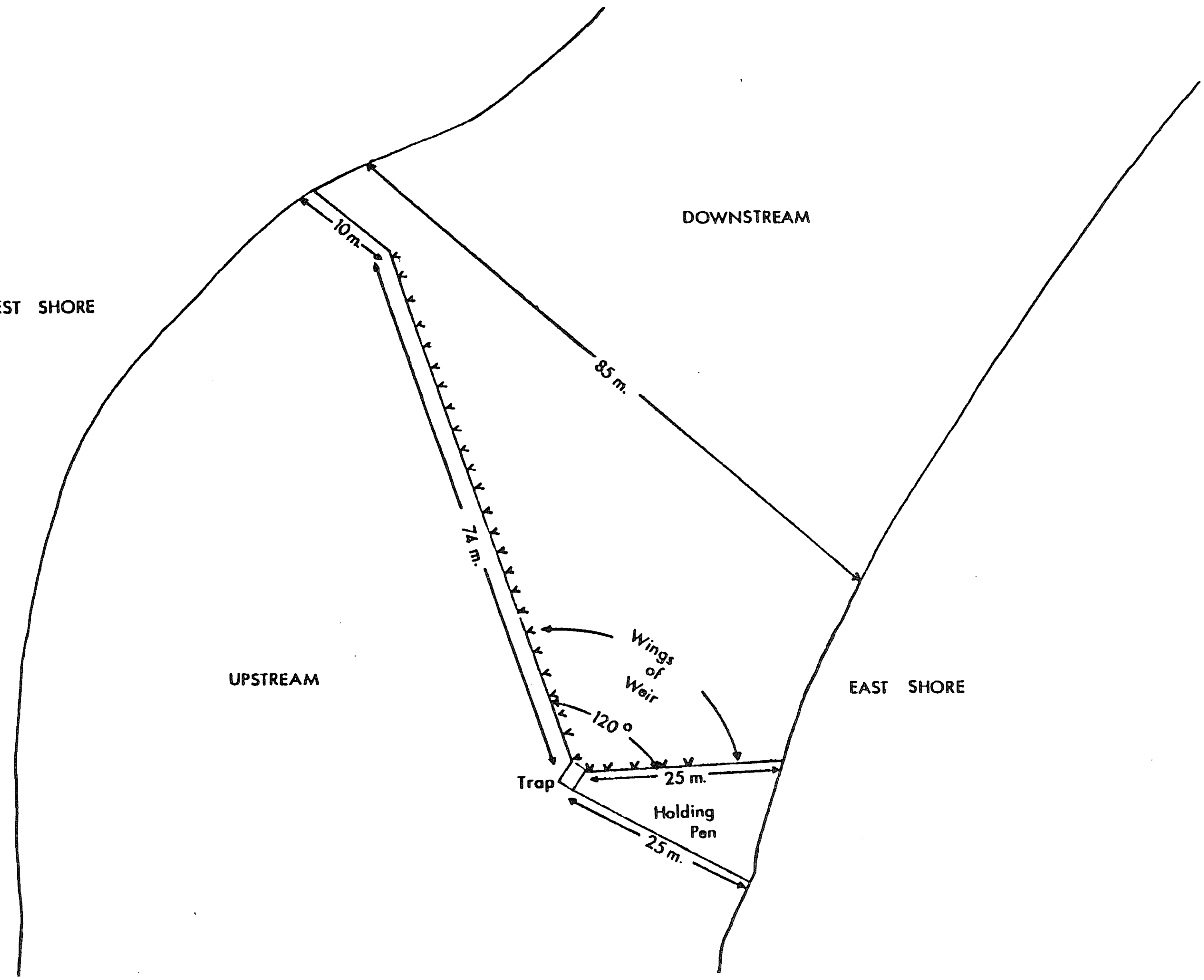



Fig. 4. Layout and dimensions of the conduit pipe weir used for the 1986 Hornaday River test fishery.

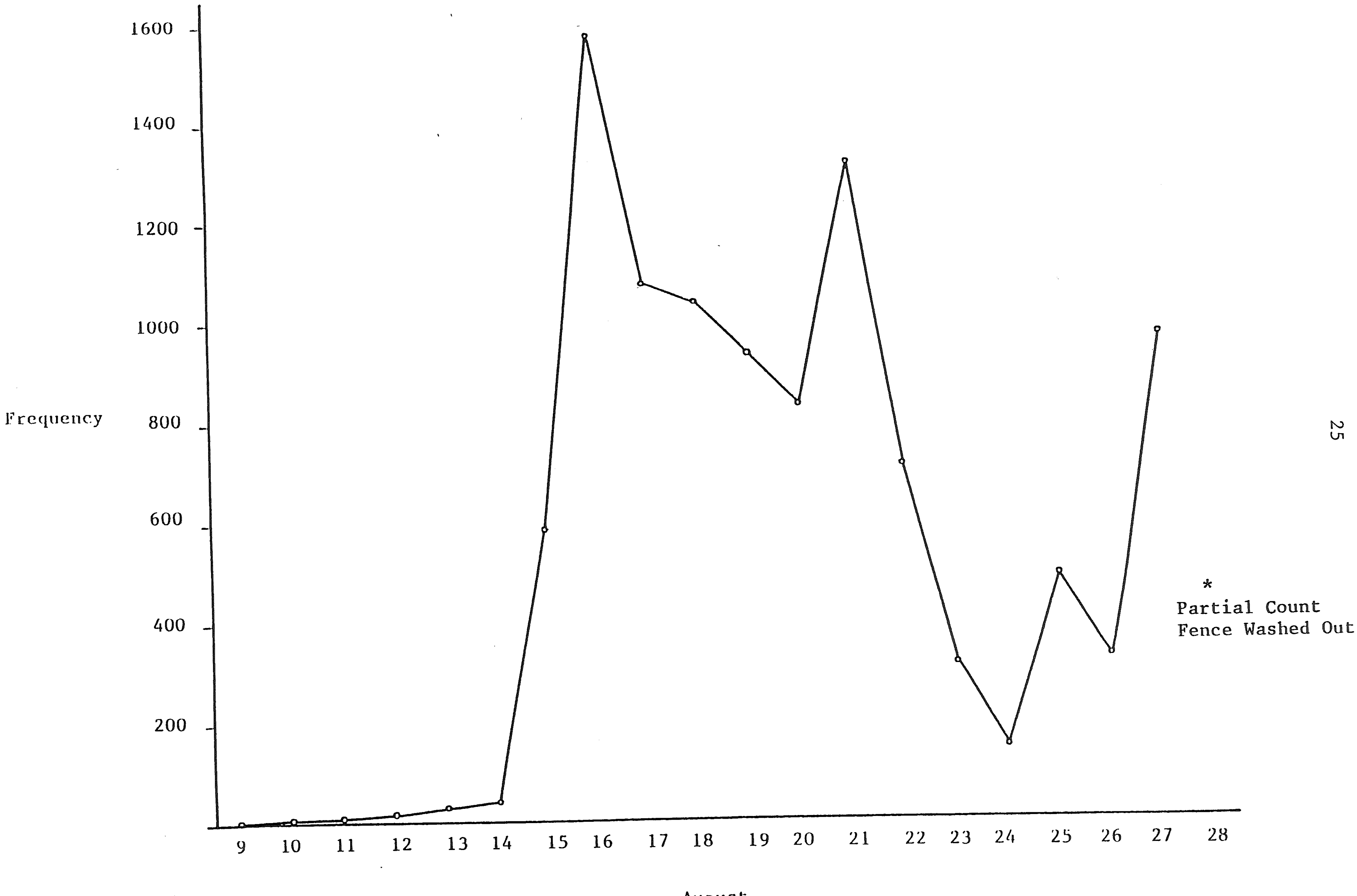
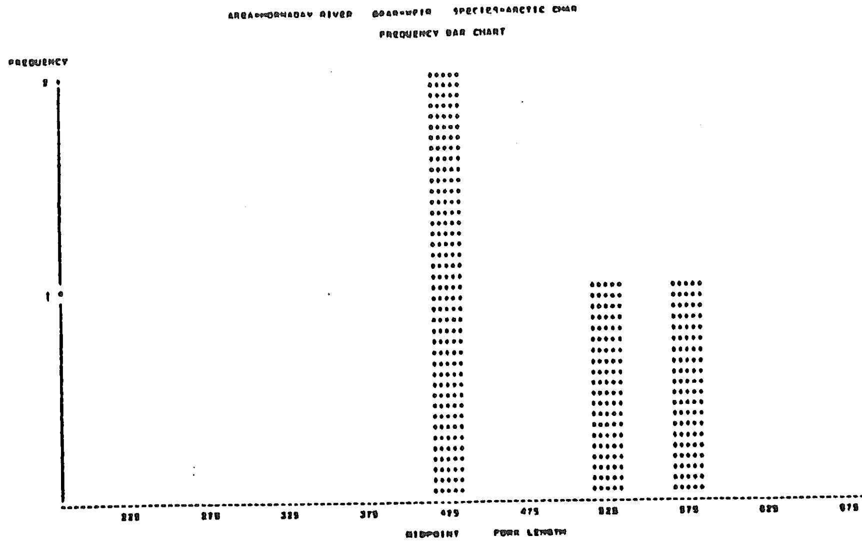
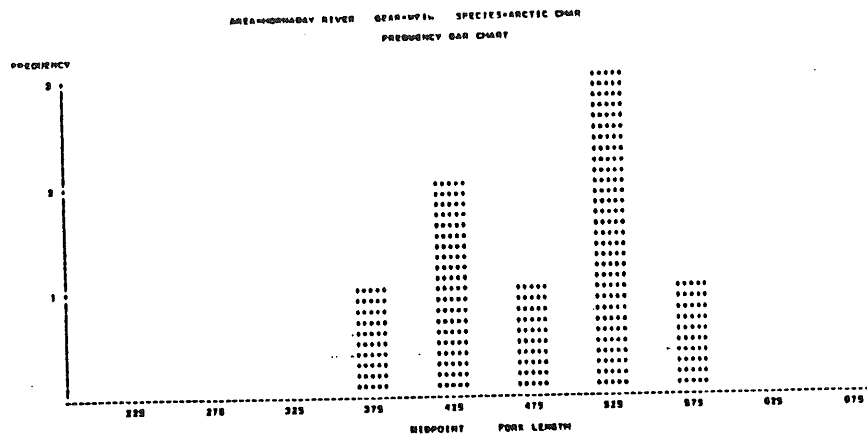


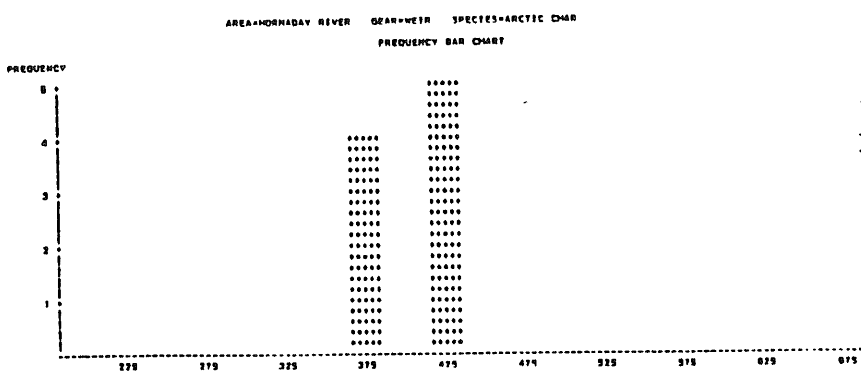

Fig. 5. Daily counts of Arctic charr passing through the weir from August 9 to August 28, 1986.




August 10
N=4

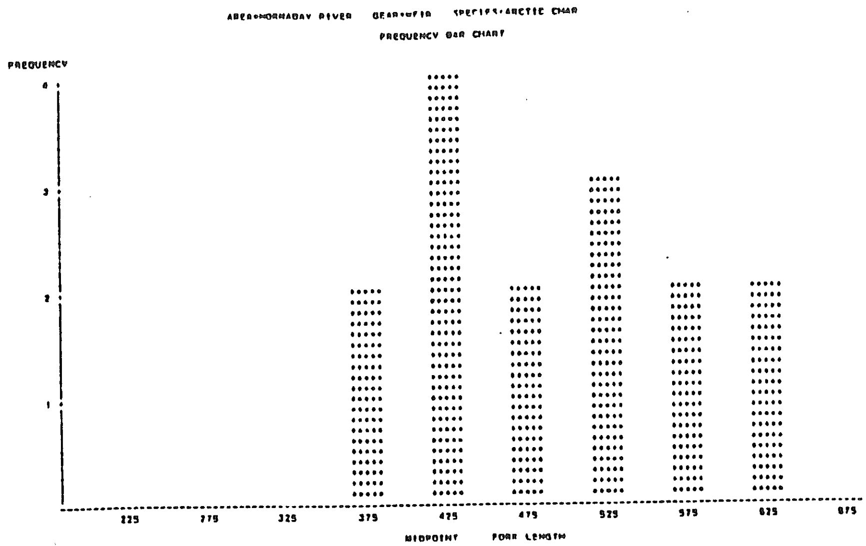



August 11
N=8

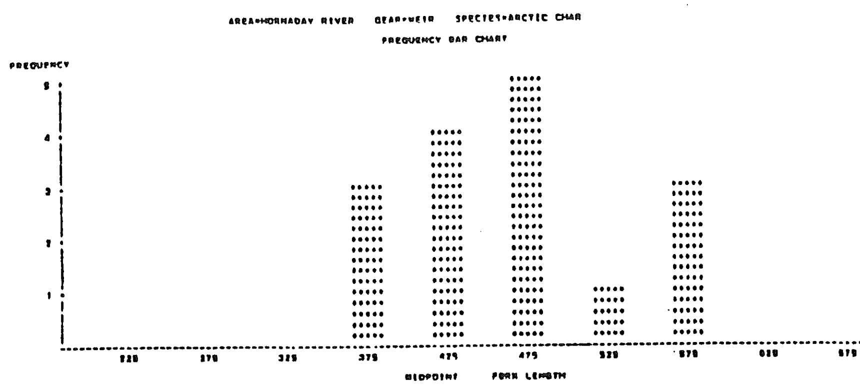



August 12
N=9

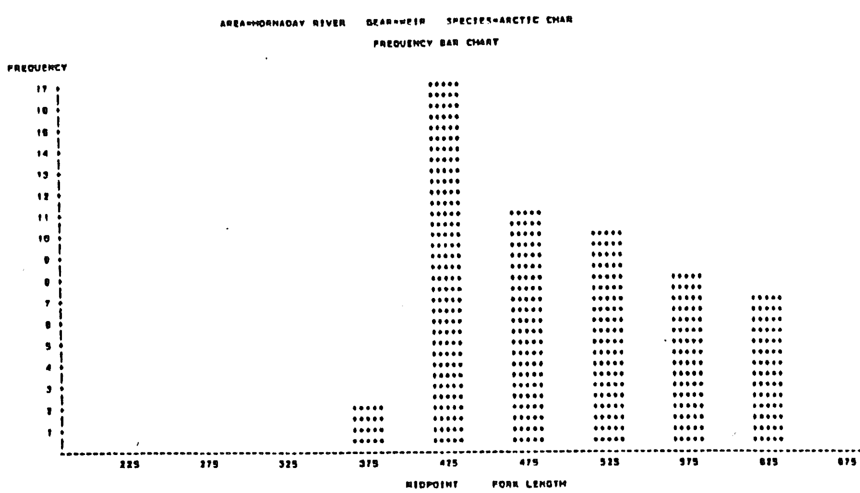
Fig. 6. Daily length frequencies of sampled Artic charr passing through the Hornaday River weir, 1986.




August 13
N=15

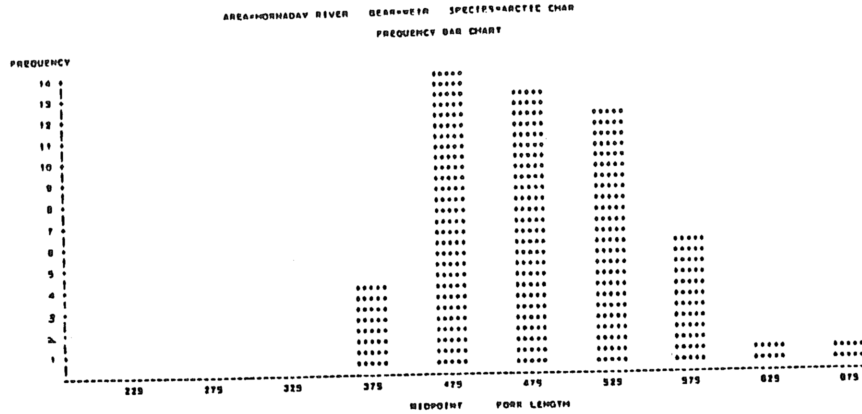



August 14
N=16

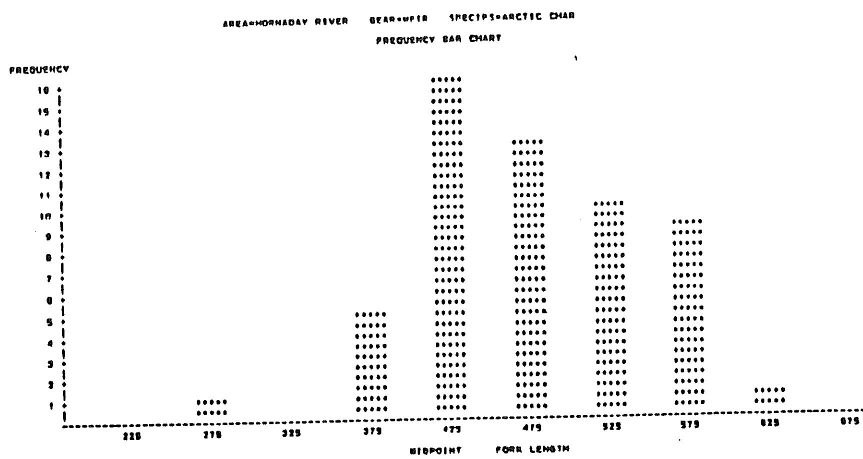



August 15
N=55

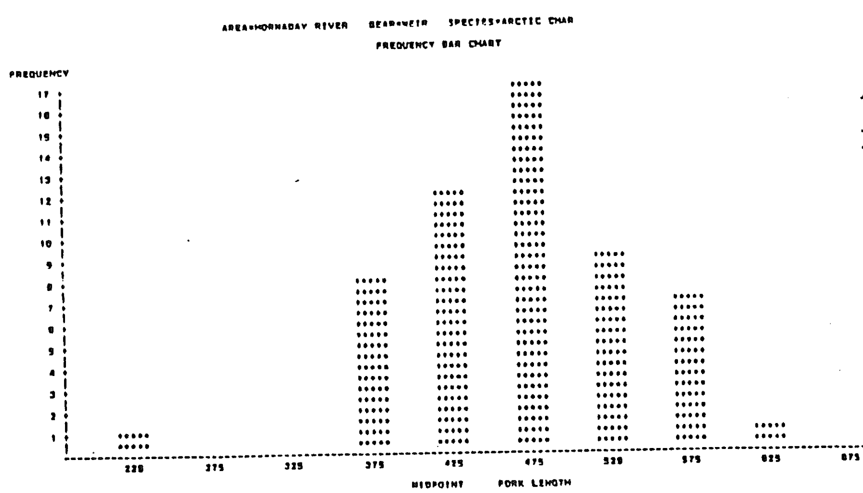
Fig. 6 continued




August 16
N=51

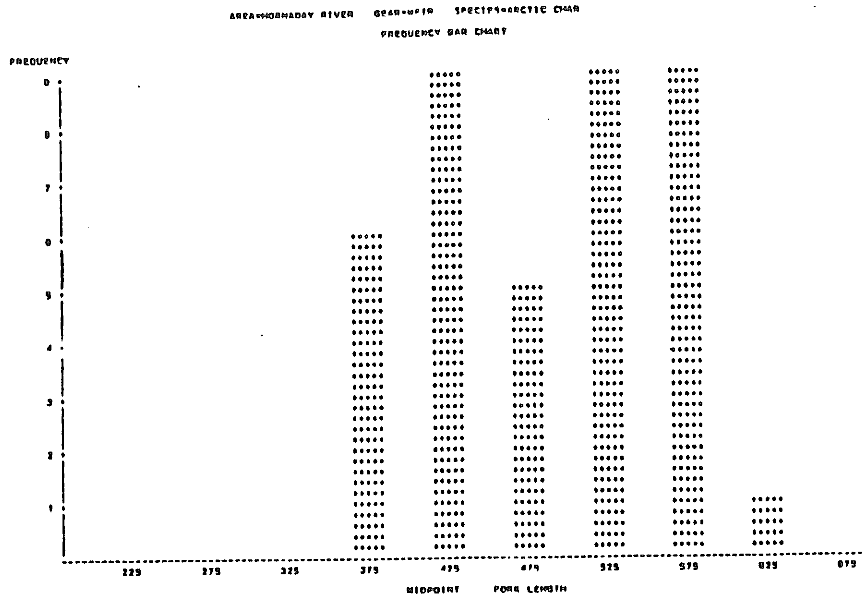



August 17
N=55

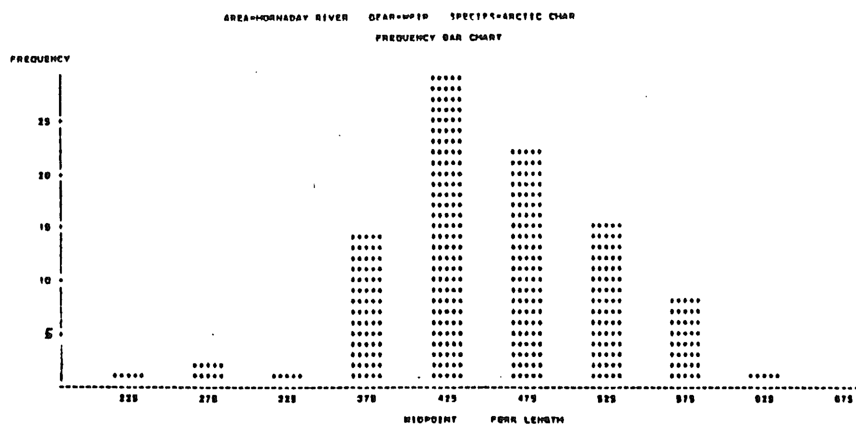



August 18
N=55

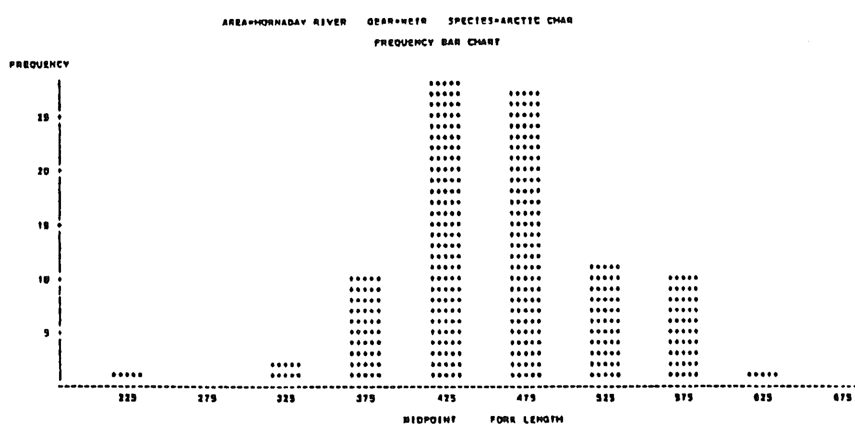
Fig. 6 continued




August 19
N=39

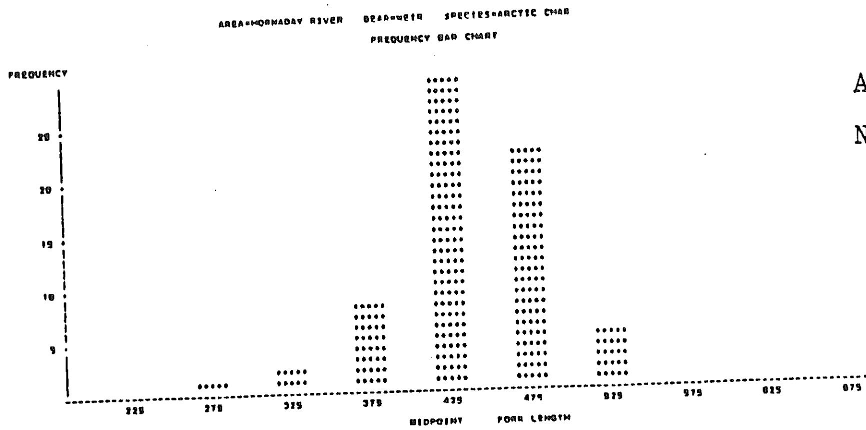



August 20
N=93



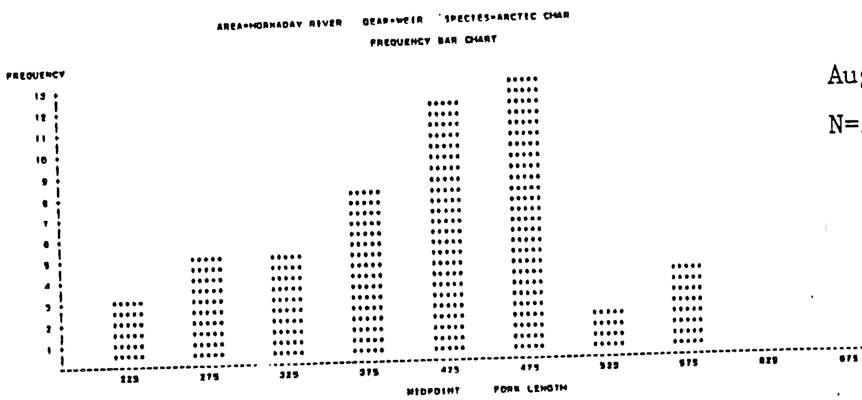

August 21
N=90

Fig. 6 continued




August 26

N=67




August 27

N=52

Fig. 6 continued

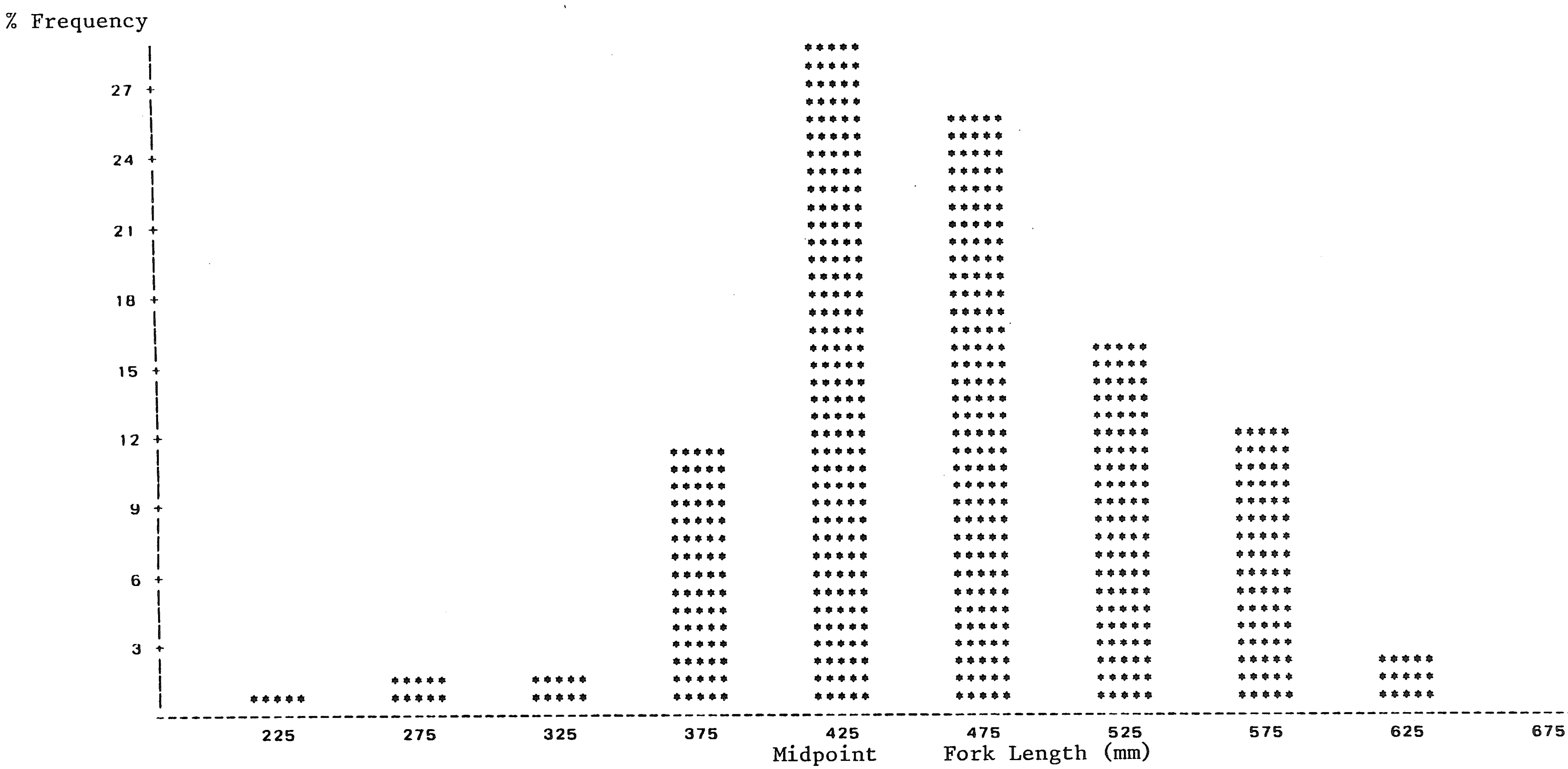



Fig. 7. Calculated total length frequency of Arctic charr passing through the weir during the 1986 Hornaday River test fishery.

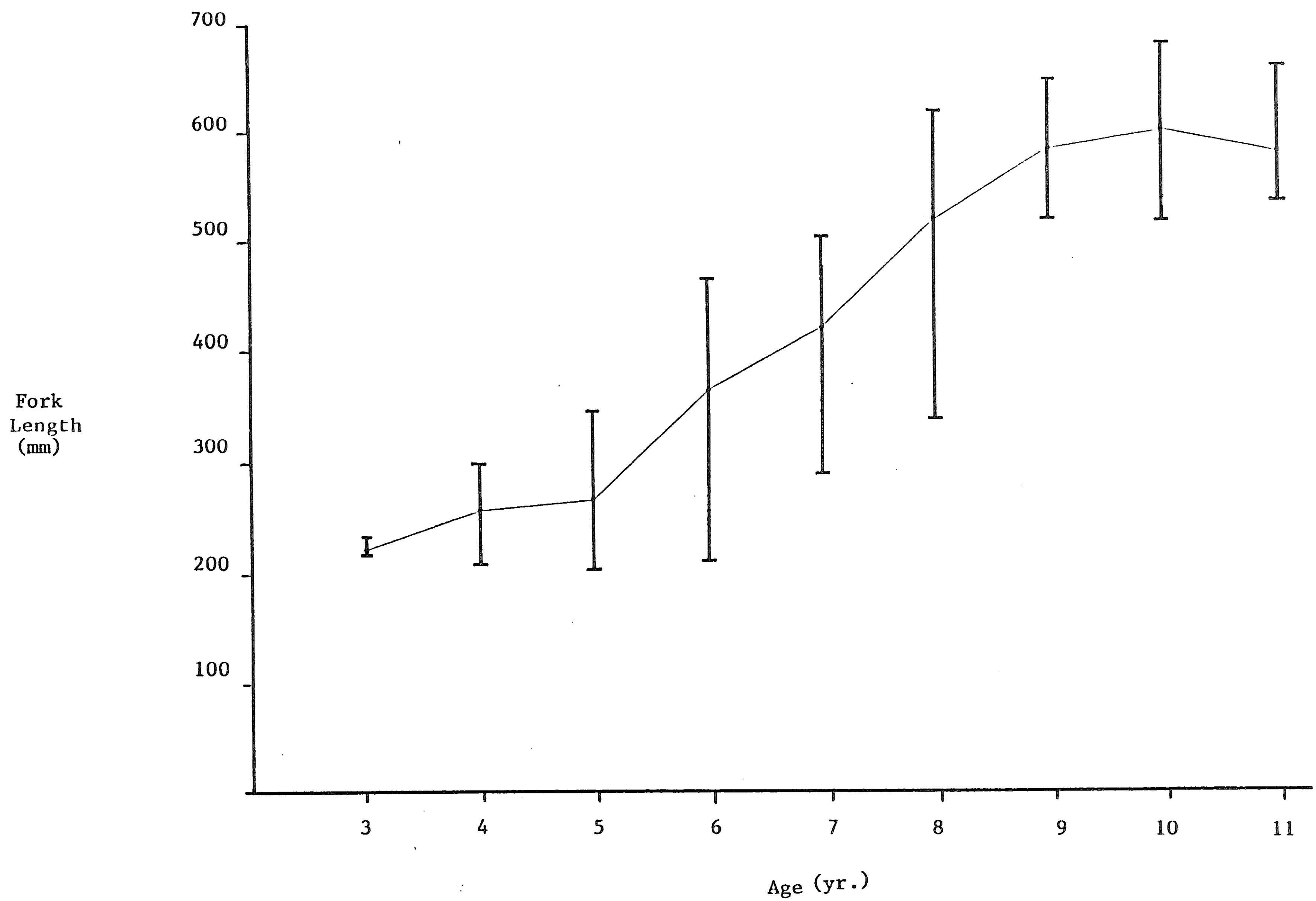



Fig. 8. Mean length and range in length for each age of Arctic charr sampled during the 1986 Hornaday River test fishery.

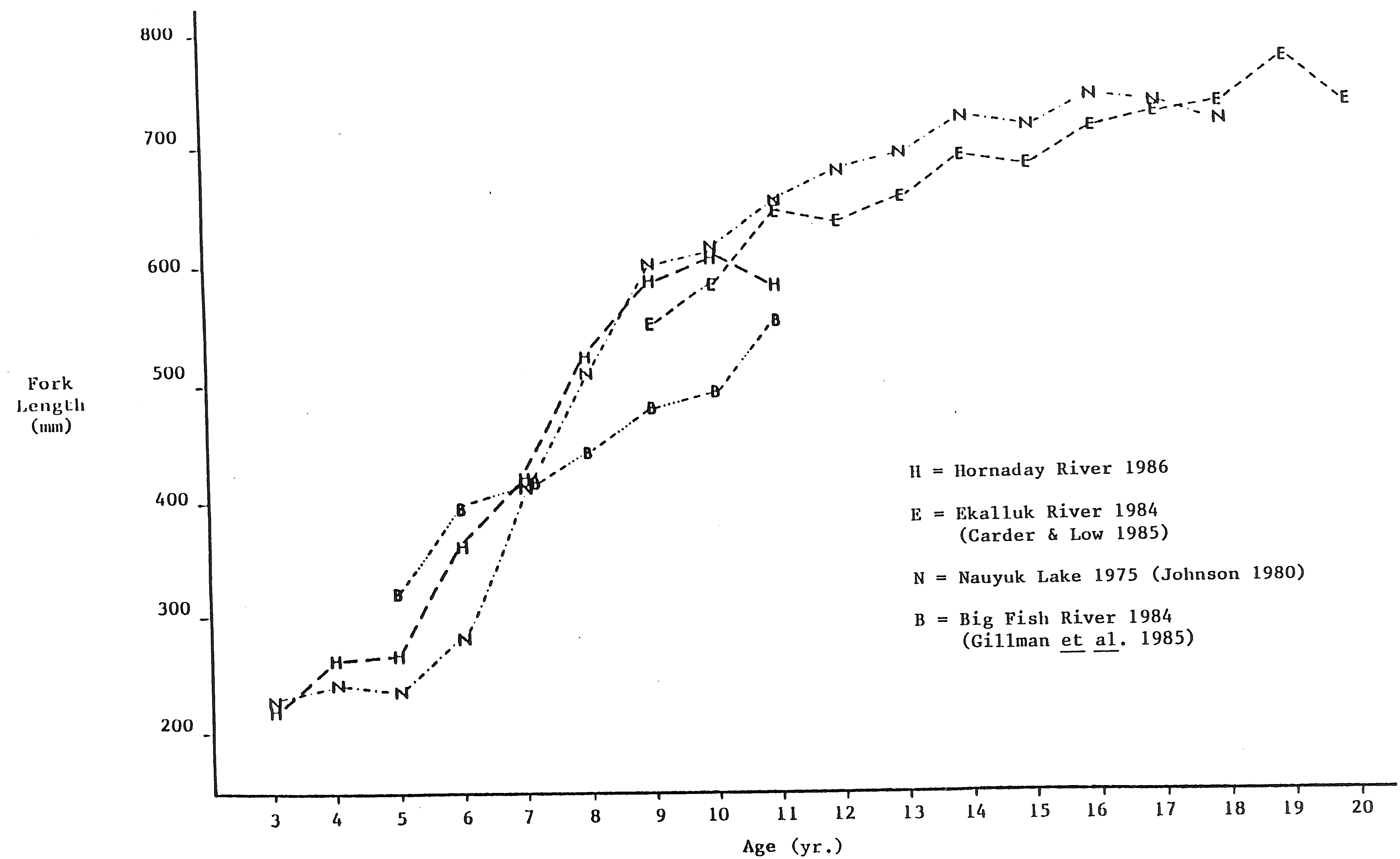



Fig. 9. Comparison of growth rates of 3 Arctic charr populations to that of the Hornaday River charr population.

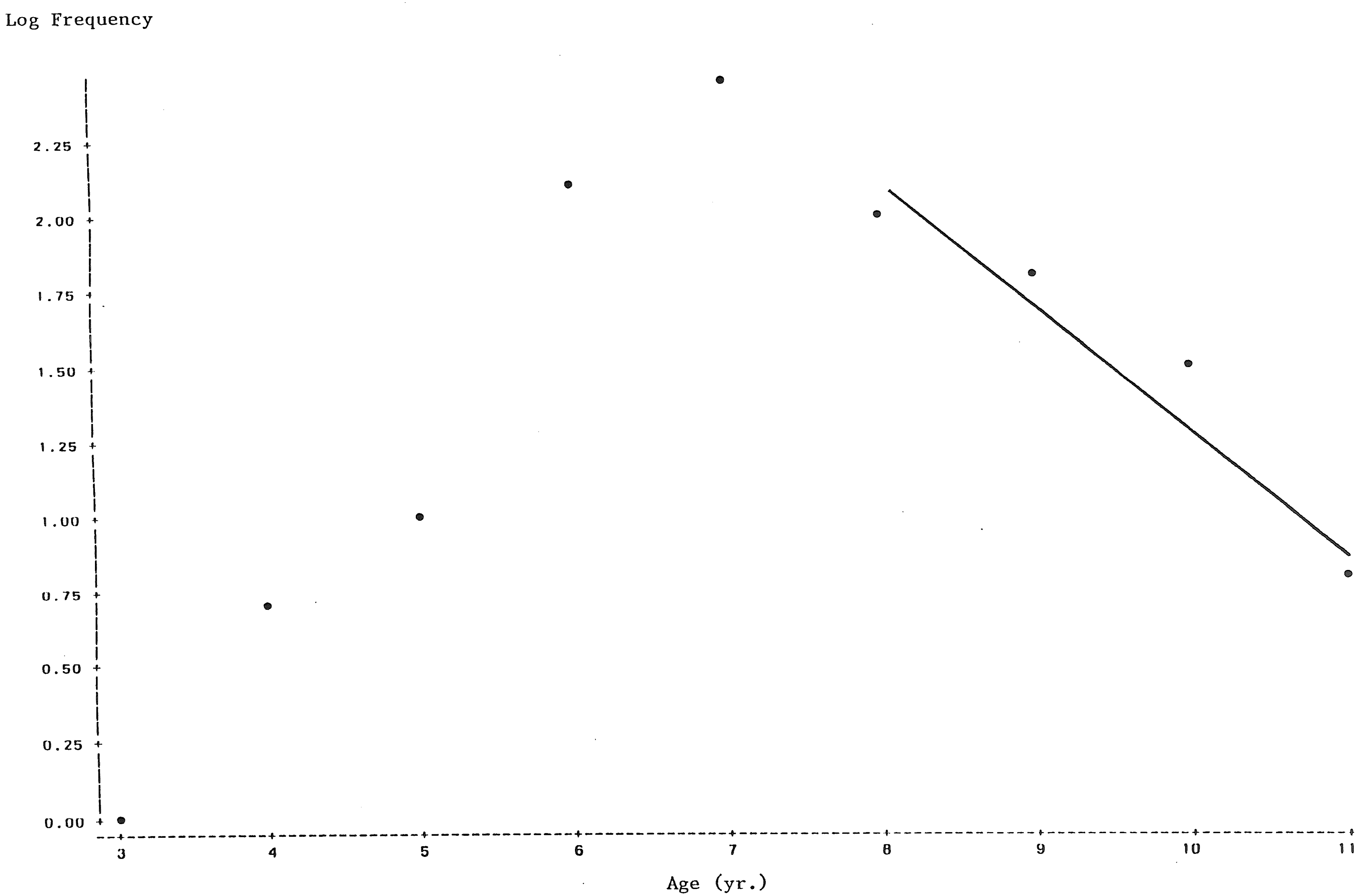



Fig. 10. Catch curve used to calculate instantaneous total mortality (Z) of the Hornaday River Arctic charr population.

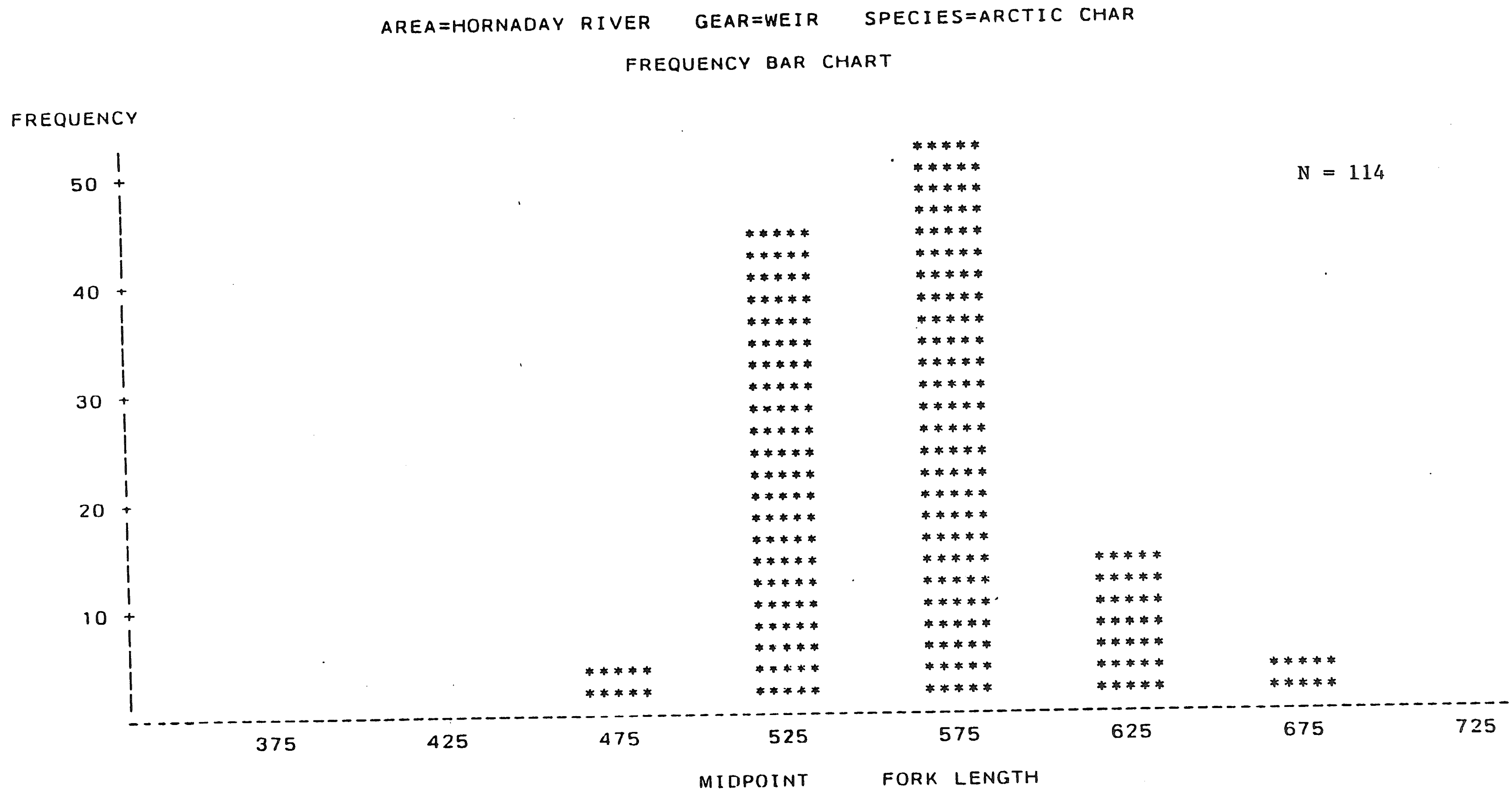



Fig. 11. Total length frequency of the commercial sample of Arctic charr taken from the weir during the 1986 Hornaday River test fishery.


Fig. 12. Total commercial harvest from the Hornaday River, 1977 through 1986.

Table 1. Commercial harvest from the Hornaday River between 1977 and 1986.

| Year | Production (kg rnd. wt.) |
| --- | --- |
| 1977 | 6341 |
| 1978 | 6023 |
| 1979 | 6795 |
| 1980 | 6427 |
| 1981 | 2721 |
| 1982 | 9072 |
| 1983 | 3400 |
| 1984 | 5300 |
| 1985 | 2764 |
| 1986 | 2402* |

* estimated

Table 2. Daily counts of fish passing through the Hornaday River weir, between August 9 and August 28, 1986.

| Date | Arctic Char | | Broad Whitefish | Longnose Sucker | Arctic Grayling | Arctic Cisco |
|---|---|---|---|---|---|---|
| 9 | 1 | | 2 | 2 | | |
| 10 | 4 | | 11 | 25 | | |
| 11 | 9 | | 39 | 53 | 1 | |
| 12 | 22 | | 96 | 16 | | |
| 13 | 30 | | 69 | 28 | | |
| 14 | 44 | | 64 | 22 | | |
| 15 | 584 | | 69 | 8 | | |
| 16 | 1570 | | 68 | 19 | | |
| 17 | 1067 | | 63 | 47 | | 1 |
| 18 | 1039 | (66) | 69 | 14 | | |
| 19 | 933 | (181) | 39 | 20 | | |
| 20 | 825 | (145) | 29 | 7 | | |
| 21 | 1308 | (313) | 17 | 10 | | |
| 22 | 706 | | 12 | 5 | | |
| 23 | 308 | | 12 | 35 | | |
| 24 | 145 | | 3 | 7 | | |
| 25 | 479 | (4) | 11 | 3 | 1 | |
| 26 | 320 | (55) | 19 | 27 | | |
| 27 | 959 | (44) | 14 | 20 | | |
| 28* | 445 | | - | - | | |
| Total | 10,798 | (808) | 706 | 368 | 2 | 1 |

() = Commercial harvest included in daily count

* = 1/4 day count

Table 3. Mean length, weight and condition factor by day for sampled Arctic charr passing through the weir during the 1986 Hornaday River test fishery.

| VARIABLE | LABEL | N | MEAN | STANDARD DEVIATION | Daily Count |
|---|---|---|---|---|---|
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=10AUG86 ------------ | | |
| | FORK LENGTH | 4 | 477.00 | 72.81 | 4 |
| | ROUND WEIGHT | 4 | 1102.50 | 538.00 | |
| | CONDITION FACTOR | 4 | 0.95 | 0.05 | |
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=11AUG86 ------------ | | |
| | FORK LENGTH | 8 | 473.88 | 71.58 | 9 |
| | ROUND WEIGHT | 8 | 1075.00 | 542.48 | |
| | CONDITION FACTOR | 8 | 0.93 | 0.11 | |
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=12AUG86 ------------ | | |
| | FORK LENGTH | 9 | 403.22 | 17.03 | 22 |
| | ROUND WEIGHT | 9 | 611.11 | 129.37 | |
| | CONDITION FACTOR | 9 | 0.92 | 0.10 | |
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=13AUG86 ------------ | | |
| | FORK LENGTH | 15 | 492.07 | 82.91 | 30 |
| | ROUND WEIGHT | 15 | 1316.67 | 703.48 | |
| | CONDITION FACTOR | 15 | 0.99 | 0.14 | |
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=14AUG86 ------------ | | |
| | FORK LENGTH | 16 | 469.00 | 68.16 | 44 |
| | ROUND WEIGHT | 16 | 1095.31 | 526.80 | |
| | CONDITION FACTOR | 16 | 0.98 | 0.12 | |
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=15AUG86 ------------ | | |
| | FORK LENGTH | 55 | 498.67 | 73.55 | 584 |
| | ROUND WEIGHT | 55 | 1462.27 | 597.70 | |
| | CONDITION FACTOR | 55 | 1.13 | 0.13 | |
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=16AUG86 ------------ | | |
| | FORK LENGTH | 51 | 482.73 | 64.50 | 1570 |
| | ROUND WEIGHT | 51 | 1319.61 | 572.06 | |
| | CONDITION FACTOR | 51 | 1.11 | 0.10 | |
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=17AUG86 ------------ | | |
| | FORK LENGTH | 55 | 474.95 | 70.46 | 1067 |
| | ROUND WEIGHT | 55 | 1252.73 | 538.96 | |
| | CONDITION FACTOR | 55 | 1.10 | 0.09 | |
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=18AUG86 ------------ | | |
| | FORK LENGTH | 55 | 471.02 | 70.77 | 1039 |
| | ROUND WEIGHT | 55 | 1188.64 | 597.00 | |
| | CONDITION FACTOR | 55 | 1.05 | 0.16 | |
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=19AUG86 ------------ | | |
| | FORK LENGTH | 39 | 487.95 | 72.93 | 933 |
| | ROUND WEIGHT | 39 | 1357.05 | 575.00 | |
| | CONDITION FACTOR | 39 | 1.10 | 0.08 | |
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=20AUG86 ------------ | | |
| | FORK LENGTH | 93 | 456.20 | 72.13 | 825 |
| | ROUND WEIGHT | 93 | 1155.11 | 507.76 | |
| | CONDITION FACTOR | 93 | 1.14 | 0.12 | |
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=21AUG86 ------------ | | |
| | FORK LENGTH | 90 | 462.09 | 66.58 | 1308 |
| | ROUND WEIGHT | 90 | 1206.11 | 493.22 | |
| | CONDITION FACTOR | 90 | 1.16 | 0.17 | |
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=26AUG86 ------------ | | |
| | FORK LENGTH | 67 | 442.39 | 49.76 | 320 |
| | ROUND WEIGHT | 67 | 985.45 | 282.51 | |
| | CONDITION FACTOR | 67 | 1.12 | 0.18 | |
| ------------ GEAR=WEIR | SPECIES=ARCTIC CHAR | | T=27AUG86 ------------ | | |
| | FORK LENGTH | 52 | 412.89 | 92.58 | 959 |
| | ROUND WEIGHT | 52 | 951.92 | 515.35 | |
| | CONDITION FACTOR | 52 | 1.25 | 0.35 | |

Table 4. Mean fork length, round weight and condition factor by age of the stratified dead sample of Arctic charr taken during the 1986 test fishery.

| | COMBINED | | | | | |
|---|---|---|---|---|---|---|
| AGE | LENGTH(MM) | | | WEIGHT(G) | | |
| (YR) | N | MEAN | SD | MEAN | SD | K |
| 3 | 2 | 224 | 8.5 | 75 | 0 | 0.67 |
| 4 | 6 | 263 | 39.4 | 188 | 92 | 0.94 |
| 5 | 10 | 269 | 57.5 | 230 | 150 | 1.02 |
| 6 | 14 | 365 | 67.0 | 527 | 262 | 0.99 |
| 7 | 21 | 422 | 55.1 | 823 | 320 | 1.03 |
| 8 | 13 | 524 | 71.9 | 1658 | 550 | 1.10 |
| 9 | 13 | 584 | 41.7 | 2122 | 479 | 1.05 |
| 10 | 7 | 604 | 62.5 | 2343 | 849 | 1.03 |
| 11 | 3 | 582 | 68.8 | 2042 | 615 | 1.02 |
| TOTAL | 89 | | | | | |
| MEAN AGE | | 7.1 | | | | |

Table 5. Mean fork length, round weight and condition factor by length interval for the commercial harvest of Arctic charr from the weir during the 1986 Hornaday R. test fishery.

| | COMBINED | | | | |
|---|---|---|---|---|---|
| LENGTH INTERVAL | | LENGTH(MM) | WEIGHT(G) | | |
| (MM) | N | MEAN | MEAN | SD | K |
| 450 | 4 | 494 | 1300 | 71 | 1.08 |
| 500 | 40 | 530 | 1664 | 158 | 1.12 |
| 550 | 54 | 571 | 2043 | 278 | 1.09 |
| 600 | 13 | 624 | 2648 | 172 | 1.09 |
| 650 | 3 | 679 | 3242 | 576 | 1.03 |
| TOTAL | 114 | | | | |
| MEAN | | 563 | 1984 | 449 | 1.10 |

Table 6. A comparison of the average size and condition of Arctic charr from test fisheries conducted throughout the Northwest Territories.

| Location | Gear | Fork Length (mm) | Weight (kg rnd. wt.) |
|---|---|---|---|
| Kuuk River[1], 1986 | 139 mm gillnets | 662 | 3054 |
| Ekalluk River[2], 1984 | 139 mm-159 mm gillnets | 694 | 3737* |
| Rankin Inlet[2], 1983 | 139 mm-159 mm gillnets | 616 | 2519 |
| Steensby Inlet[3], 1985 | 139 mm gillnets | 635 | 3097 |
| Jayco River[2], 1983 | Weir | 644 | 2662 |
| Hornaday River, 1986 | Weir | 563 | 1984 |

[1] Baker (1986)
[2] Carder and Low (1985)
[3] Kroeker (1985)
* Dressed weight

APPENDIX I. Materials for the conduit weir and trap used on the Hornaday River, 1986.

| Material | Dimensions | Number of Pieces |
|---|---|---|
| Conduit, thin walled, galvanized | 1.27 cm diam. 1/2" diam<br>1.52 m long 5ft long. | 2700 |
| Channel Iron | 7.6 cm x 3.48 cm x 0.63 cm<br>3.04 m long 3" x 1 3/8" x 1/4"<br>predrilled 10ft lengths | 56 |
| Standard Pipe | 4.08 cm ID, 4.8 cm OD<br>2.13 m long 1 5/8" ID, 1 7/8" OD 1/4" thick<br>predrilled 7ft long | 29 |
| Angle Iron | 0.63 cm x 8.87 cm x 6.33 cm<br>15.8 cm long 1/4" x 3 1/2 x 2 1/2<br>predrilled 6 1/4" long | 60 |
| U-bolts, galvanized | 5.07 cm x 0.95 cm 2" x 3/8" | 60 |
| Carriage bolts | 19.1 cm x 1.27 cm 7 1/2" x 1/2" | 29 |
| Burlap sacks | | 100 |
| Lumber, spruce | | |
| plywood | 1.22 m x 2.43 m x 1.27 cm | 2 |
| "2 x 4's" | 2.43 m 8ft 2x4's | 80 |
| Stucco Wire | 1.22 m x 30.4 m x 2.54 cm mesh 1" mesh | 2 |
| Stove Pipe Wire | 15.2 m/roll 50ft roll | 2 |
| Black Plastic Mesh | 1.8 m x 30.4 m x 2.54 cm mesh | 1 |
| T-bars | 1.8 m | 12 |
| Nails, staples | | |